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Real and Imagined Body Movement Primes Metaphor Comprehension

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Abstract

We demonstrate in two experiments that real and imagined body movements appropriate to metaphorical phrases facilitate people's immediate comprehension of these phrases. Participants first learned to make different body movements given specific cues. In two reading time studies, people were faster to understand a metaphorical phrase, such as *push the argument*, when they had previously just made an appropriate body action (e.g., a push movement) (Experiment 1), or imagined making a specific body movement (Experiment 2), than when they first made a mismatching body action (e.g., a chewing movement) or no movement. These findings support the idea that appropriate body action, or even imagined action, enhances people's embodied, metaphorical construal of abstract concepts that are referred to in metaphorical phrases.

Keywords: Metaphor; Body movement; Imagination

1. Introduction

Speakers often talk about abstract concepts as if they were physical entities such as when saying *grasp a concept, chew on the idea, swallow your pride, push the argument*, and *spit out the facts*. These metaphorical expressions are physically impossible to perform; unlike nonmetaphorical action statements, such as *grasping a spoon, chew on the gum, swallow your food*, or *push the carriage*. Why is it reasonable to talk about abstract entities like concepts, ideas, pride, and arguments in terms of bodily actions like grasping, chewing, pushing, swallowing, and so on?

One possibility is that people talk of the abstract in bodily language precisely because many abstract concepts are partly understood in terms of enduring embodied metaphors (Gibbs, 1994, 2003, 2006; Lakoff & Johnson, 1999). For example, we conceive of "ideas" as physical entities that we can grasp, juggle, hold on to, chew, swallow, digest, and spit out given wide-spread conceptual metaphors like IDEAS ARE PHYSICAL ENTITIES. This

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embodied metaphor maps source domain knowledge of our bodily experiences with physical entities onto the target domain of ideas, a mapping that gives rise to a range of meaning correspondences, such as that ideas can be possessed, hard to handle, deliberately examined, accepted, and rejected. A huge body of research in cognitive linguistics demonstrates the ubiquity of embodied metaphors in structuring at least some aspects of a large number of abstract domains (e.g., time, causation, spatial orientation, political and mathematical ideas, emotions, the self, and concepts about cognition, morality) across many spoken and signed languages (Gibbs, 1994, 2006; Yu, 1998; Gibbs & Steen, 1999; Lakoff & Johnson, 1999; Kovecses, 2000). Different psycholinguistic evidence reveals that embodied conceptual metaphors motivate people's use and understanding of different metaphoric language (Gibbs, Bogdonovich, Sykes, & Barr, 1997; McGlone & Harding, 1997; Boroditsky & Ramscar, 2002; Gibbs, 2006; Gibbs & Franks, 2002; Gibbs, Lima, & Francuzo, 2004). These experimental studies indicate that people's recurring embodied experiences often play a role in how they tacitly make sense of why many words and expressions have the specific meanings they do, and in their immediate processing of many verbal metaphors.

There remains heated debate, however, in cognitive science as to whether people either ordinarily encodes metaphoric representations for abstract concepts (Murphy, 1996, 1997) or automatically access conceptual, embodied metaphors during conventional language understanding (Kennedy & Vervaeke, 1993; Keysar, Shen, Glucksberg, & Horton, 2000; Glucksberg, 2001). At the very least, though, there is a great deal of data from a variety of research domains to suggest that enduring metaphorical knowledge has some role in people's interpretation of some, but not all, verbal metaphors (Gibbs, 2006).

For the most part, previous studies on the activation of conceptual metaphor during metaphor understanding suggest that this occurs as a purely cognitive process (Gibbs, 1994). Thus, understanding the conventional phrase *Our relationship has hit a dead-end street* is partly accomplished through the activation of the conceptual metaphor LIFE IS A JOURNEY in long-term memory. This enduring chunk of metaphorical knowledge has a source domain (e.g., JOURNEY) that is grounded in the pervasive bodily experience, or image-schema, of SOURCE-PATH-GOAL. Activation of the image-schematic structure of the conceptual metaphor LIFE IS A JOURNEY enables listeners to infer a range of correspondences between life and journeys that constrains people's interpretation of what *hit a dead end street* means in conjunction with talk about relationships (e.g., that the relationship can not continue further, that the participants in the relationship feel stuck, etc). But this entire process of accessing a specific conceptual metaphor is mostly viewed as activating abstract, schematic, disembodied knowledge that is not tied to ongoing bodily action.

This article reports the results of two studies that are consistent with a different conception of metaphor understanding, and language processing more generally. We show that real and imagined body action may play a direct role in people's immediate comprehension of some forms of verbal metaphor, such as *grasp a concept,* which may come into existence because of recurring correlations in embodied activity (e.g., between physical handling of object and being able to understand them). Recent empirical and theoretical advances in cognitive sciences suggest that understanding many words and phrases involves some partial reinstantiation of one's experiences with its real-world referent (Lakoff & Gallese, 2005; Zwaan 2005). For instance, one proposal suggests that each word in a phrase like *grasp the concept* activates a

"functional web" of knowledge related to the word that includes both experiential representations of the words (e.g., their spelling and sound), and experiential representations associated with their referents (e.g., perceptual, kinesthetic, and emotional information), such as what it may feel like to grasp, or try to grasp, objects in the world (Pulvermuller, 2002). The specific functional web activated depends, of course, on the situational and linguistic context (i.e., the web activated by one word may be constrained by the webs of previous words and one's situation model of the discourse up to that point), and the listener's own purposes and interests. Most importantly, understanding what many words and phrases mean requires that listeners construct an experiential simulation of the described situation. When hearing *grasp the concept* listeners engage in, or imagine engaging in, aspects of a body action, such as grasping, that facilitates metaphorical construal of the abstract idea of *concept* as a physical entity, such that concepts indeed can be things that are grasped, held on to, dropped, misplaced, and so on.

Our aim in this paper is to test only part of the above view, namely whether overt and imagined bodily movement facilitates people's immediate processing of metaphorical phrases like *chew on the idea, swallow your pride*, and *stretch for understanding*. These phrases refer to common metaphorical actions (i.e. actions that can be conceptually, but not physically, performed) and, as such, represent only one kind of metaphoric language. We hypothesized that engaging in body movements associated with these phrases should enhance the simulations that people create when understanding different verbal metaphors. For example, making a grasping movement before seeing *grasp the concept* facilitates people's access to their embodied, metaphorical understanding of *concept*, even if concepts are not things that people can physically grasp. People's conceptual understandings of what a "concept" is need not be completely embodied and metaphorical. However, some construals of "concept," and other abstract terms, are partly rooted in embodied metaphor that may be highlighted by engaging in body actions relevant to what people mentally do with concepts and other abstract entities.

Our hypothesis departs radically from the very traditional belief that the above action phrases have meanings that were once transparently metaphoric, but over time have lost their original metaphoricity and now exist as clichés or dead metaphors (see Bowdle & Gentner, 2005; Gibbs, 1994 for discussions of how some expressions become dead metaphors). Under this view, contemporary speakers learn to produce and comprehend phrases such as *grasp a concept* or *chew on the idea* as a matter of convention, and perhaps have a phrasal lexicon containing pairings of different conventional expressions and their accepted meanings. For instance, people know that the phrase *grasp the concept* refers to understanding the concept, but are unaware as to why this phrase has the particular meaning it does. This position would not predict that body movement related to a metaphorical phrase should enhance people's comprehension of its meaning.

Previous research demonstrates that appropriate bodily actions facilitate semantic judgments for action phrases such as *aim a dart* (Klatzky, Pelligrino, McCloskey, & Doherty, 1989) and *close the drawer* (Glenberg & Kaschak, 2002). The current studies extend this work on comprehension of literal actions to the comprehension of metaphorical statements that are physically impossible to perform (e.g., *grasp a concept*). At one level of analysis, the action of grasping, for instance, does not mesh with people's conceptualizations of abstract entities, given that things like "concepts" do not afford actions like grasping. However, our claim is that people ordinarily conceive of abstract entities like concepts, ideas, pride, arguments and

so forth in embodied metaphorical terms as physical al objects which can afford actions like grasping, pushing, chewing, and so forth. In this way, our studies extend the idea of linguistic processing as perceptual/sensorimotor simulation to verbal expressions that are nonsensical in the physical world, yet completely sensible within the embodied mind. Furthermore, the present studies also demonstrate, unlike previous research, that even imagined actions may facilitate immediate processing of language.

2. Experiment 1

Participants in the first study were seated in front of a computer that presented them with a series of trials where an icon flashed on the screen, prompting participants to perform the appropriate bodily action. After doing this, a metaphorical phrase appeared on the screen and participants had to simply read, and push a button as soon as possible, indicating that they understood its meaning. Some of the bodily actions participants first performed were relevant to the metaphor and some were not. A third type of trial involved no prime at all. We expected that matching body movements should facilitate reading times for the metaphors, compared to the mismatching actions, or no action conditions.

2.1. Method

2.1.1. Participants

Fifty-one University of California, Santa Cruz, undergraduates participated in exchange for partial course credit. All participants were native speakers of English.

2.1.2. Design and materials

The experiment was a single factor within-subjects design with three levels: matching prime, mismatching prime, and no prime. Nine metaphorical phrases were created that combined bodily actions, such as push, shake, throw, grasp, or chew, with abstract concepts like concept, idea, understanding, or truth. Table 1 presents a list of these phrases. In addition, a nonverbal icon was paired with each action word (see Table 1).

An independent study first assessed whether college students understood the metaphorical phrases as having metaphorical meaning, Twelve UC Santa Cruz students read the metaphorical phrases intermixed with the filler phrases. For each one, participants first judged with the phrase had "metaphorical" or "nonmetaphorical" meaning (no definition of "metaphorical" or "nonmetaphorical" was provided). Across all participants and items, 96% of the metaphorical phrases were indeed seen as conveying "metaphorical" meaning and 100% of the filler phrases were judged as being "nonmetaphorical." Other research examining people's mental images for the same set of metaphorical phrases showed that people could report details about their images revealing their specific understandings of the way certain abstract concepts could be metaphorically associated with certain bodily actions (e.g., why it was possible to associate "grasping" with an abstract entity such as a "concept") (Gibbs, Gould, & Andric, 2006). These two studies provide excellent evidence that people readily interpret the metaphorical phrases as having specific, and often complex, metaphorical meanings.

Table 1
Actions, corresponding icons, & metaphorical phrases

Action	Icon	Metaphorical Phrase
Stamp	^	Stamp out a fear
Push	&	Push the argument
Swallow	#	Swallow your pride
Sniff	*	Sniff out the truth
Spit	:	Spit out the facts
Shake	%	Shake off a feeling
Grasp	“	Grasp a concept
Chew	/	Chew on an idea
Stretch	{	Stretch for understanding

Filler Phrases
Study for an exam
Be nice to your dog
Take a long nap
Dislike the painting
Remember the friend
Care about the earth
Listen to a speech
Daydream for hours
Write an adventure novel

In the main study, the entire experiment consisted of nine total trials: three of each of the three prime types. Thus every participant saw each of the nine phrases only once: 3 preceded by a matching action, 3 preceded by a mismatching action, and 3 preceded by no action. Each action was performed twice during the experiment: once preceding either a matching or mismatching phrase and once preceding a filler item. Between each trial, a filler phrase was presented (see Table 1). For each participant, the particular prime assigned to each specific phrase and the order of presentation was randomized and counter-balanced. A Gateway 486 computer with a SuperLab Pro software package recorded the reaction time to each phrase automatically.

2.1.3. Procedure

Participants first watched a video that depicted a female actor, sitting in a chair, performing six actions (empty-handed pantomime), each paired with a distinct icon that was shown before each event. Each action, and its corresponding icon, was demonstrated four times. The participants learned six of nine possible actions: *stamp* (the actor strongly lifted her leg and stamped down her foot on the floor), *push* (the actor placed her hand close to her chest and strongly pushed outward toward the observer), *swallow* (the actor opened her mouth, lifted her chin, and then swallowed by closing her mouth and moving her head backwards), *sniff* (the actor leaned over and sniffed the space in front of her by moving her nose down and then up in two locations), *spit* (the actor leaned back slightly and then quickly leaned over, moving her lips as if spitting), *shake* (the actor raised her right hand and arm and shook her hand quickly), *grasp* (the actor reached out her arm and hand toward the observer and with open hand then

quickly closed it as if grasping something in the air), *stretch* (the actor slowly raised both arms from her side and extended them outward as if stretching), *and chew* (the actor leaned her forward slightly with an open mouth and rapidly made several chewing motions).The names of the actions were never given to the participants. After viewing the video, participants had to closely enact the different actions given their respective cues. If they could not, they watched the video until they could demonstrate perfect performance.

Participants were then individually seated at a computer and given an additional two minutes of practice performing the actions after viewing the icons displayed on the computer monitor. Following the two-minute practice period, the participants were told that they would see a series of trials in which either an icon or a blank screen would first appear. If an icon appeared, they were to perform the corresponding action and then press the spacebar. If a blank screen appeared, they were to simply press the spacebar. A verbal phrase would then appear and they were to read it, and push a button as soon as they understood its meaning. Once the response (pressing the spacebar) was made, the phrase would disappear and the next trial began after a 3 second delay.

To ensure that the participants carefully read the phrases, they were told that they would later be tested on their memory for the phrases. The participants were then given three sample trials to familiarize themselves with the program format. They were also covertly observed during the experiment to verify that they performed each action correctly.

2.2. Results

Reaction times 3 standard deviations above the mean were excluded from the analyses (i.e., all times above 6 seconds, 6.5% of the data). These outliers were evenly distributed across the different experimental conditions. A one-way ANOVA on participants' reading times revealed a significant main effect for prime type in both the subjects $F(2, 150) = 4.4$, $p < 0.05$, and items $F(2, 24) = 6.6$, $p < 0.01$ analyses. Subsequent comparisons using protected two-tailed t-tests revealed that comprehension times in the matching prime condition ($m =$ 2629 milliseconds, $sd = 874$) were significantly faster than in the mismatching prime condition ($m = 3172$ milliseconds, $sd = 864$), $t(48) = 3.3$, $p < 0.01$ and the no prime condition ($m =$ 2927 milliseconds, $sd = 687$), $t(48) = 4.4$, $p < 0.001$. The times for the no prime and mismatching prime conditions did not significantly differ. These data support the idea that engaging in appropriate body movements primes people's speeded comprehension of certain metaphorical phrases (i.e., an action metaphor compatibility effect).

Participants were asked after the experiment whether they noticed any specific relation between the different body actions and the following metaphors. But no participants reported doing so. Yet they may have been primed to verify metaphors in the matching prime condition not because of their body movements alone, but because their body movements reminded them of a word that was identical to one in the following word string they saw. We examined this possibility by having a separate group of 16 people watch the video of the actor holding up cards with the individual icons and making the body movements associated with these icons. The participants learned how to make the appropriate movement for each icon, according to the same criterion required for participants in Experiment 1, and then generated a word best described the action. Analysis of these data showed that participants correctly came up with

the relevant word for each action 43% of the time. This included cases where the participants gave the appropriate word with an "ing" ending, as in saying that the actor was "pushing" when the actual word in the verbal metaphor was "push."

Participants in this task sometimes generated semantically related words such as "gulp" for "swallow." When these semantically related guess were added to identical matches, the proportion of relevant guesses for the words describing the body actions rose to 0.60. These semantically related guesses, when substituted for the main verbs in the metaphor statements often changed the statements' meaning such that they were no longer metaphorical. Thus, "gulp your pride" does not make metaphorical sense in the way that "swallow your pride" does, most likely due to the difference in the actions of gulping and swallowing as related to what occurs when one is swallows their pride.

Nonetheless, we conducted two further analyses on the individual phrases to see if there was a negative correlation between the probability of guessing the exact or semantically-related word given a body action and experimental participants' reading times for the different metaphorical statements. A first analysis showed that the items for which people showed the greatest exact guessing accuracy were the ones that showed the weakest primary effects in Experiment 1, while many of the actions that people were worst at guessing the right word actually produced the greatest priming effect in the main study. In fact, the correlation between the reading times for specific stimulus items, collapsing across participants, and the number of correct guesses for words representing different actions is 0.18, a finding that is not only not significant, but opposite to the negative correlation predicted by the lexical priming account. When synonymous words were included, the correlation decreased to 0.02, a finding that is again not significant and in the opposite direction predicted by a lexical priming account.

These data suggest that the action metaphor compatibility affecting Experiment 1 is not due to the body actions simply activating a relevant word for the metaphorical phrases, or even the idea that seeing the word primes, in a backward manner, the recognition that the previous action has a specific verbal label.

3. Experiment 2

Does imagining relevant body action have the same facilitatory effect on metaphor processing as does actual physical movement? Brain-imaging studies demonstrate the activation of sensorimotor cortex occurs even in the absence of physical movements when people are engaged in various mental tasks (Decety, Perani, Jeannerod, Bettinardi, Tadary, Woods, Mazziotta, & Fazio, 1994). Imagining oneself performing an action can also increase memory for phrases involving those actions (Engelkamp, 1995; Hornstein & Mulligan, 2001). These findings suggest the possibility that asking people to merely imagine themselves engaging in different body movements may enhance metaphor comprehension in the same way that physical movement does. We examined this idea in Experiment 2.

3.1. Method

3.1.1. Participants

Forty-five students from the same population as Experiment 1 participated in this study.

3.1.2. Design, material, procedure

The same design and materials used in Experiment 1 were employed in Experiment 2. The procedure was nearly identical to that in Experiment 1; the only difference being that instead of performing the action when presented with the icon, participants simply imagined themselves performing it.

3.2. Results

Reaction times three standard deviations above the mean were excluded from the analyses (i.e., all times above 6 seconds, 6.4% of the data). Once again, participants did not report noticing any specific relation between the imagined actions and the following verbal phrases. The distribution of these outliers was even across the different experimental. A one-way ANOVA revealed a significant main effect for prime type in both the subjects $F(2, 132) = 4.2$, $p < 0.05$, and items $F(2, 24) = 15.7$, $p < 0.0001$ analyses. Subsequent protected two-tailed t-tests revealed that reaction times in the matching prime condition ($m = 2675$ milliseconds, $sd = 926$) were significantly faster than in the mismatching prime condition ($m = 3269$ ms, $sd = 933$), $t(42) = 5.5$, $p < 0.0001$ and the no prime condition ($m = 3060$ milliseconds, $sd = 945$), $t(42) = 2.6$, $p < 0.05$. Reaction times for the no prime condition were also significantly faster than for the mismatching prime condition $t(42) = 2.3$, $p < 0.05$.

Additional analysis of the response times to the different items and the number of correct guesses for the words reflecting different body actions, as reported in the control study in Experiment 1, showed a correlation of 0.12, which was both non-significant and again in the opposite direction predicted by the lexical priming alternative hypothesis. When synonymous words that participants generated in the control task were included in the analysis the correlation was –0.03, which again was not significant or close to the strong negative correlation predicted by the lexical priming account. The data from Experiment 2, therefore, are not likely due to body actions simply activating a relevant word for the subsequent metaphorical phrases encountered. Our evidence from the two control studies reported in Experiments 1 and 2 is similar to the failure to find effects of lexical guessing in motor priming of literal action phrases (Klatsky et al., 1989).

These findings for Experiment 2 on imagined body movement replicate those found in Experiment 1 with real body movement. One difference between the two studies is that there was a significant interference effect obtained in the present experiment where people who imagined performing an inappropriate action were then slower to read a metaphor than when they did not imagine any action.

4. General discussion

These studies demonstrate that performing an action, or merely imagining performing an action, facilitates comprehension of metaphorical phrases related to those actions. It is physically impossible to do metaphorical actions such as *push the argument*, *chew on the idea*, or *spit out the truth*. But these metaphorical phrases are sensible because people ordinarily conceive of many abstract concepts in embodied, metaphorical terms. Engaging in, or imagining

doing, a body action, such as chewing, before reading a metaphorical phrase, such as *chew on the idea*, facilitates construal of the abstract concept as a physical entity, which speeds up comprehension of metaphorical action phrases. These findings extend to understanding impossible metaphorical actions the results of previous studies showing that appropriate body movement facilitates processing of nonmetaphorical action statements (Klatzky et al., 1989; Glenberg & Kaschuk, 2002).

Our data are consistent with the idea that some aspects of linguistic processing are tied to what the body is doing at any one moment. People may, for instance, be creating partial, but not necessarily complete, embodied simulations of speakers' messages that involve moment-by-moment "what must it be like" processes that make use of ongoing tactile-kinesthetic experiences. More dramatically, these simulation processes operate even when people encounter language that is abstract, or refers to actions that are physically impossible to perform. Understanding abstract events, such as *grasping the concept*, is constrained by aspects of people's embodied experience as if they are immersed in the discourse situation, even when these events can only be metaphorically realized. This interpretation of our findings is congruent with a body of emerging evidence in cognitive science showing intimate connections between perceptual/sensorimotor experience and language understanding (Barsalou, 1999; Glenberg & Roberston, 2000; Glenberg & Kaschak, 2002; Zwaan, Stanfield, & Yaxley, 2002; Richardson, Spivey, Barsalou, & McRae, 2003; Zwaan, Madden, Yaxley, & Aveyard, 2004). Yet the present results address one major criticism of perceptual symbol theories by showing that experiential accounts can account for abstract concepts and metaphoric language, as well it can concrete concepts and linguistic terms.

Our findings do not necessarily generalize to all kinds of metaphor. Although many metaphoric phrases refer to bodily activities and sensations, there are other types of metaphoric language that have significantly fewer relations to the human body, or have source domains that are not directly linked to embodied experiences (e.g., many resemblance metaphors such as "Lawyers are sharks"). For this reason, we do not claim from the present data alone, then, that embodied activity is necessarily central to all aspects of metaphor comprehension. We suggest, nonetheless, that even some aspects of how people infer the metaphoric meanings of metaphors like "Lawyers are sharks" could engage bodily simulation processes as people create imaginative scenarios in which the metaphor makes sense (e.g., lawyers are like sharks in moving quickly and aggressively toward their victims). Finding evidence for this speculative possibility is a task for future research. For the moment, it seems clear that certain bodily activity appears to provide a major source for metaphorical concepts and the language people use to refer to these ideas.

These experiments do not distinguish between the possibility that sensorimotor activity is actively recruited in metaphor comprehension and the idea that only abstract concepts related to certain metaphors are activated from bodily action. Engaging in a particular body motion may activate relevant sensorimotor processes, as well as abstract concepts associated with these actions. For example, making a grasping motion may activate abstract concepts related to this activity, such as ideas, concepts, beliefs, etc., even if these abstract concepts are not fundamentally represented in an embodied manner. Even if the conceptual representations for abstract concepts are independent of immediate bodily action, they still may be partly formed via sensorimotor processes and retain something about their embodied origins. Under

this latter possibility, people's bodily experiences of handling physical objects may be used in creating, and maintaining elaborate conceptual representations for many abstract concepts. But these "embodied" concepts need not be continually tied, and immediately influenced, by ongoing body activity. As we have shown here, even imagining appropriate body actions facilitate processing, which is likely due to activation of relevant pre-motor and motor cortex regions during mental imagery of the relevant actions.

Finally, there are important communicative reasons for why people actually move their bodies in particular ways when speaking that may be directly related to attempts to facilitate people's comprehension of language. Studies of people, both experts and novices, speaking about abstract topics (e.g., mathematics, physics) show that appropriate physical gestures are often employed to articulate something about the topic at hand (McNeil, 1992; Roth & Lawless, 2002). Thus, mathematicians exhibit gestural images for the concept of limits, both direct and inverse (e.g., hand moving a straight line in front of the body for direct limits, and hand looping downward and back up for inverse limits) (McNeil, 1992). These gestures embody ("give a body to") abstract, metaphorical ideas, and sometimes precede the language spoken to enhance listeners' understandings of speakers' complex, abstract communicative intentions (Alibali, Heath, & Myers, 2001). Similarly, people may reach out their hand and grasp the air as, or before, saying *I finally grasped that concept* to facilitate addressees' comprehension of the metaphorical idea of grasping a concept. We do not necessarily claim that speaker intentionally produce relevant body motions for these communicative purposes. Yet people's automatic positioning of their bodies as they think about certain ideas and concepts may provide relevant cues as to their communicative intentions when understanding the metaphoric words they say.

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